

Understanding the Spread of Antibiotic Resistant Pathogens in Hospitals

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Epidemiological (risk factor) studies, clinical trials of interventions, and mathematical modeling can all be used to improve our understanding of why antimicrobial resistant pathogens become a problem (or why they do not), and to inform our choice of measures to control them. This talk will discuss the uses of each of these kinds of approaches, with illustrations, and will describe some of the common misconceptions about the information contained in each.

Risk factor studies aid in the identification of reasons why individuals may become infected with resistant pathogens, thereby suggesting measures to reduce this risk. These studies are well-known and usually straightforward to interpret, but two points will be emphasized about their interpretation: first, the choice of control group, and second, the relation of individual risk factors to group-level (hospital, regional, national-level) risk factors. An example from a community-acquired pathogen, *S. pneumoniae*, will be described (Lipsitch, *Clin Infect Dis.* 2001; 32: 1044), and parallels in hospital epidemiology mentioned.

Intervention studies are designed to evaluate the impact of particular interventions, by determining how much better (if at all) the outcome is with the intervention than it would have been without. The multiple variables influencing clinical outcomes, the complexities of evaluating transmissible diseases (using statistical approaches that were designed for studies in which every data point – i.e., patient – is independent of every other), and the difficulties of doing multi-center studies, make this evaluation more difficult than it may appear. We will discuss some considerations in how to design and interpret studies in light of these difficulties.

Finally, mathematical models can help to improve our intuition about the processes underlying the spread of resistant pathogens, identify the conditions under which results from one study might extrapolate to another, suggest interventions that might not have been obvious otherwise, and describe conditions under which a particular intervention should be most effective. Because of the small populations of most hospital units and the importance of randomness in determining outcomes in such small populations, models are *not* particularly useful for making precise forecasts in hospital epidemiology. A very simple model of hospital transmission (Lipsitch et al., *Proc Natl Acad Sci USA* 2000; 97:1938) will be briefly described and used to illustrate some of these uses. Other published and unpublished uses of models, and what we have learned from them, will be highlighted.
